ON MORPHOLOGY STUDIED THROUGH ALL DEVELOPMENTAL STAGES OF A MYOBIID MITE (*RADFORDIA ENSIFERA*) FIRST RECORDED FROM JAPAN

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The mite, reported here as a first recorded species in Japan, *Radfordia ensifera* (POPPE, 1896) (Myobiidae : Acarina), was taken from albino rats, and then many specimens of the mite were collected from wild Norway rats, too, in Tokkyo and Kochi. By the use of the ample material, I studied its external structure, involving body- and leg-chaetotaxy, through all stages of ontogeny to find some overall characters different from those of its related species, and as well the seasonal prevalency of its occurrence and the mode of life on some portions of its host bodies were investigated. Since POPPE[6] discovered this species about 70 years ago, a number of papers, cited in the literature, with morphological descriptions of adult mites alone have been published, but no papers seem to have dealt with the above subjects.

This mite is found much more commonly on Norway rats than on other hosts as is in Europe. Other allies I picked from Japanese small mammals were *Myobia musculi* and *R. affinis*. The ontogeny of these mites consists definitely of two larval and two nymphal stages before the adult.

I am deeply grateful to Dr. R. TANAKA of our Laboratory and to Dr. M. SASA, Department of Parasitology, Institute for Infectious Diseases, University of Tokyo, for their helpful suggestions.

Techniques

A suitable technique to isolate the mite from rats for microscopical observation was required because of its very small size, and a lump of hairs was pulled out from several parts on the rat body, but the customary method that a rat is suspended by its tail, could not be used successfully. The hairs, surveyed, were taken out of the following parts ; head, neck and shoulder, back, base of tail, abdomen, hind limb, mouth-parts. The medium commonly called 'Gater solution' was used to stain mites in microscopic preparations.

Occurrence and habit

R. ensifera occurred generally on the head of hosts, especially in a good number on the mouth parts, but it was almost lacking at the base of tails and hind limbs and commonly few on the rest parts. The mites of every stage were found clasping small soft hairs, while eggs lied on rather large ones.

The prevalence of infestation by the mite (percentage of hosts infested) was relatively high, 49 % out of 49 albino rats and 42.8 % out of 63 Norway rats. A dead albino rat

Table 1 Measurements (μ) of body setae,

	setae \ *	Female			Male			2nd nymph		
		1	2	3	4	5	6	7	8	9
dorsal	1	56.7	50.1	71.5	70.0	61.5	55.8	8.6	10.7	7.2
	2	53.2	57.2	60.1	15.4	14.3	15.7	28.6	27.2	49.7
	3 a	107.8	103.0	114.4	18.2	17.2	18.6	93.0	95.8	77.2
	3 b	47.2	68.6	78.7	99.4	101.5	88.7	50.1	55.8	55.1
	4 a	71.4	65.8	70.1	—	—	—	54.3	65.8	57.2
	4 b	49.0	47.2	57.2	98.7	97.2	77.2	75.8	77.2	68.6
	5	82.0	82.9	98.7	—	—	—	65.8	74.4	68.6
	6 a	74.0	77.2	77.2	39.2	31.5	31.5	64.4	72.9	68.6
	6 b	14.2	11.4	10.0	—	—	—	42.9	48.6	44.1
	7 a	17.7	14.3	14.3	11.2	8.6	7.2	57.2	60.1	45.8
	7 b	16.2	11.4	12.9	8.4	8.6	7.2	67.2	71.5	61.5
	8 a	8.9	11.4	7.2	—	—	—	—	—	—
	8 b	364.0	364.0	385.0	378.0	371.0	336.0	252.0	266.0	231.0
	8 c	10.6	10.0	8.6	—	—	—	—	—	—
ventral	1 a	27.2	21.5	21.5	18.6	24.3	21.5			
	1 b	28.6	27.2	27.2	24.3	17.2	21.5	—	—	—
	1 c	25.7	24.3	20.0	21.5	14.3	15.7			
	2 a	24.3	25.7	28.6	21.5	25.7	21.5	8.6	8.6	11.4
	2 b	5.4	10.0	6.0	10.0	6.4	5.1	—	—	—
	3 a	12.9	14.3	10.0	11.4	11.4	8.6	11.4	8.6	10.0
	3 b	5.7	11.4	8.6	10.0	8.6	7.2			
	5 a	12.9	14.3	14.3	8.6	10.0	8.6	10.0	7.9	10.0
	5 b	7.2	8.6	8.6	8.6	8.6	7.2			
	6 a	28.6	18.6	22.9	24.3	28.6	24.0	7.0	9.3	8.6
	6 b	5.7	7.2	7.2	8.6	4.3	7.2			
	8	12.4	11.4	12.9	7.2	6.4	7.2	—	—	—
B. L.		462.0	588.0	462.0	392.0	385.0	322.0	336.0	303.6	434.2
B. W.		266.0	308.0	238.0	224.0	196.0	168.0	252.0	233.0	254.2

* Individual no.

was found infested with abundant mites all over the body surface. In general, the mite number attached to hosts tended to increase with progress of days under rearing of wild rats. The most mites in every stage were gained in winter and spring, but none other than eggs was found in summer.

Description

Each stage of this mite possesses its own systematic, morphological features. Such are most clearly seen in genitalia, number and structure of legs and body- and leg-chaetotaxy. As for stage-characters, the prime point can be recognized in that adults and nymphs have the 4 th pair of legs, which are vestigial in 1st nymph, and nymphs may be distinguished

body length and body width.

1st nymph			2nd larva			1st larva		
10	11	12	13	14	15	16	17	18
8.6	7.2	7.2	5.7	7.2	5.7	2.9	4.3	5.0
37.2	27.2	27.2	21.5	21.5	20.0	8.6	7.2	7.2
77.2 37.2	71.5 44.3	78.7 48.6	60.1 30.0	65.8 40.0	64.4 31.5	20.0 7.1	18.6 4.6	18.6 7.1
57.2 54.3	42.9 44.3	52.9 52.9	37.2 35.8	38.6 42.9	44.3 42.9	14.3 14.3	17.2 11.4	15.7 12.2
57.2	54.3	57.2	47.2	48.6	47.2	20.0	21.5	27.2
60.1 35.8	50.1 35.8	57.2 30.0	40.0 24.3	42.9 22.9	54.3 24.3	15.7 18.6	22.9 27.2	20.0 21.5
45.8 50.1	45.8 50.1	50.1 50.1	30.0 40.0	38.6 40.0	34.3 37.2	14.3 —	18.6 —	14.3 —
— 254.2 —	— 229.5 —	— 218.9 —	— 222.4 —	— 204.7 —	— 194.2 —	— 68.6 —	— 60.1 —	— 57.2 —
—	—	—	—	—	—	—	—	—
7.2 —	8.6 —	8.6 —	5.7 —	4.3 —	5.7 —	2.1 —	2.7 —	1.4 —
10.0	9.3	11.4	8.6	7.2	7.2	—	—	—
11.4	8.6	10.0	5.7	7.2	8.6	—	—	—
—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—
282.4	315.9	268.3	314.2	314.2	268.3	88.7	85.8	85.8
194.2	218.9	190.6	187.1	183.6	176.5	55.8	52.9	50.1

from adults by absence of genitalia. For convenience of comparison in chaetotaxy of body setae (Table 1 and 2), a kind of formula is offered here; the setae are tentatively classified into 1 to 8 rows in a similar idea as was proposed by SASA[13] in chiggers. The individual measurements of 18 mites arranged after my formula are shown in Table 1, for it is of aid in seeing differences between species or stages.

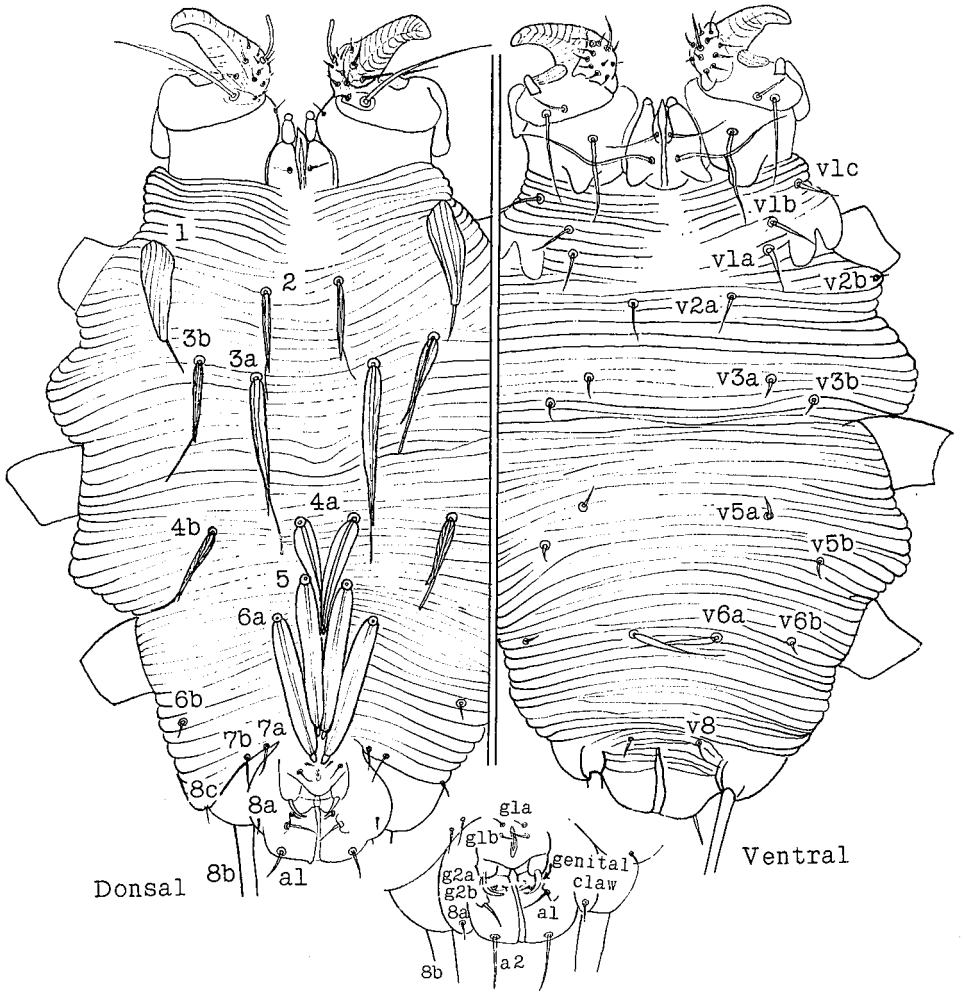
General characters : The mite is relatively small in general, body length being ca. 500 μ in females and less in males and other stages. The body without pigments and eyes is flat, soft, having a needle-like, very long chelicera in all stages. Skin has fine, cross stripes all over body surface. All legs well developed, similar in size, but leg I fairly modified in all stages, and leg II in nymphal and larval stages has only one tarsal claw as contrasted to paired claws in adult. Legs of the first pair equal, formed of discernible

Table 2 Comparison of the body-chaetotaxy formulae between each stages in *R. ensifera*.

	setae No.		Female	Male	2nd nymph	1st nymph	2nd larva	1st larva
dorsal setae	1		eb	Lb	snb	snb	snb	sn
	2		Lb	nb	nb	nb	nb	snb
	3	a	Lb	nb	Lbf	Lbf	Lbf	snb
		b	Lb	Lb	Lbf	Lbf	nbf	snb
	4	a	F	—	Lbf	Lbf	Lbf	snf
		b	Lb	Lb	Lbf	Lbf	Lbf	snf
	5		F	—	Lbf	Lbf	Lbf	snf
	6	a	F	n	Lbf	Lbf	Lbf	snf
		b	sn	—	Lbf	Lbf	Lbf	nf
	7	a	n	sn	Lbf	Lbf	nf	snf
		b	n	sn	Lbf	Lbf	nf	—
	8	a	sn	sn	—	—	—	—
		b	Tn	Tn	Tn	Tn	Tn	Tn
		c	sn	sn	—	—	—	—
ventral setae (V.)	1	a	n	n	—	—	—	—
		b	n	n				
		c	n	n	—	—	—	—
	2	a	n	sn	sn	sn	sn	sn
		b	sn	sn				
	3	a	n	sn	sn	sn	sn	—
		b	sn	sn				—
	5	a	n	sn	sn	sn	sn	—
		b	sn	sn				—
	6	a	L	n	sn	—	—	—
		b	sn	sn		—	—	—
	8		sn	sn	—	—	—	—
genital setae	1	a	sn	sn	—	—	—	—
		b	sn	sn	—	—	—	—
	2	a	claw	—	—	—	—	—
			sn					
		b	sn	—	—	—	—	—
anals.	1		sn	—	—	←	—	—
	2		n					

Remarks m : microsetae, sn : short nude setae ($\leqq 8\mu$), n : nude setae ($8.1 \sim 30.0\mu$), Ln : long nude setae ($30.1\mu \leqq$) b : barbed setae, e : expanded s., Tn : long posterior s., F : foliaceous s., f : subfoliaceous s..

segments ; segmt. I unmodified, broader than long with a ventral tubercle projecting backward, II slightly broader than long, with two ventral tubercles, III with one powerful clasping tubercle projecting outward and two small ones. Leg II with equal, paired terminal claws short and slightly curved. Legs III and IV each with a single, long and curved claw. A pair of long, tail-like setae, as long as body, arise in the posterior body margin in all stages.



genital and anal setae

Fig. 1 *Radfordia ensifera*, female, dorsal and ventral views.

Female : It is a remarkable feature also of this species that setae 4a, 5 and 6 broad, flattened into blades, although not so much as in *R. lancearia*. The female is less modified than the male as well as the nymph and larva, so it was selected as the standard for description. Body chaetotaxy ; seta 1 lengthwise striped, very basebroadened, with a slender tip joint. 2, 3a, 3b and 4b each striated, slightly broad at base, with a spur near its tip, and 3a is about twice as long as others. The complete posterior row is formed of 6b to 8c very minute, without spur, except 8b being an outermost seta longer than body. All setae of genital and anal groups are rather short and nude (Fig. 1, Table 2), nearly the same being seen in *M. musuculi*, too. As to ventral setae (Fig. 1), there are short setae, vla, vlb, vlc and v2a, v2b at level of leg II and the same ones, v3a, v3b, v5a, and v5b befor and behind leg IV. Two setae, v6a and v6b are at level of leg IV, the former being longer and closer to median line. The last seta v8 is in front of anal area.

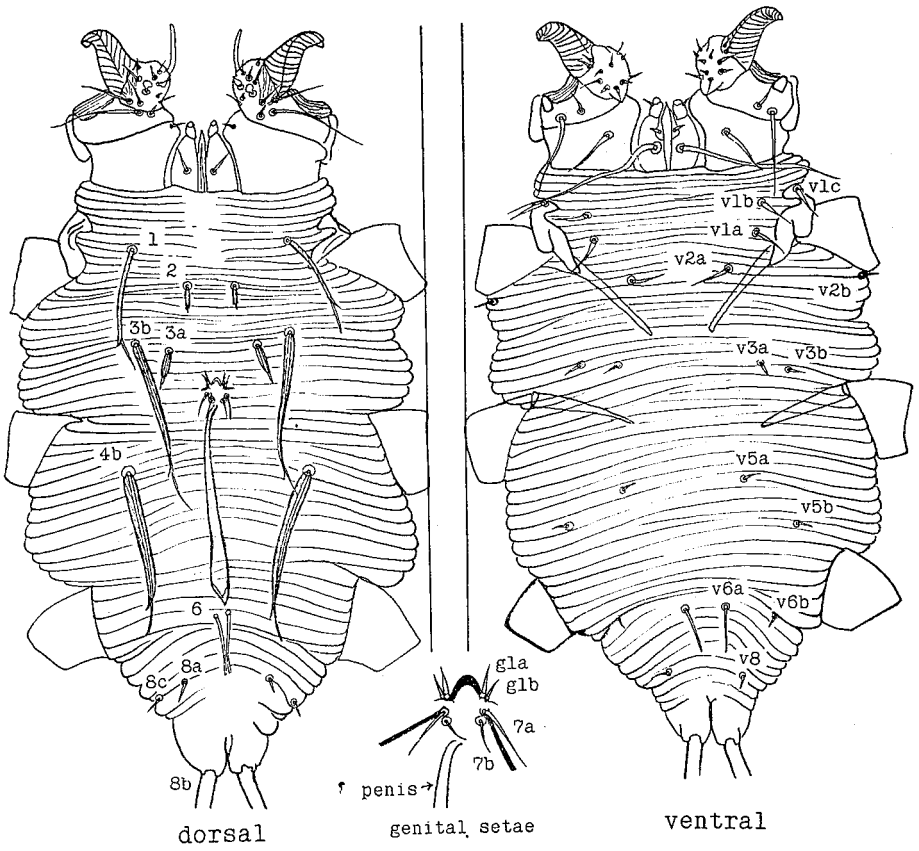


Fig. 2 *R. ensifera*, male, dorsal and ventral views.

Male: It is well different from the female in structure of genital pore with penis and in very slender hinder part of body. Male dosal setae are generally thinner than female', and there are paired small setae 6 and a rod-like pennis, having ca. 1/4 of body length, instead of leavelike, developed setae (4a, 5, 6a) of females. The setae 3b and 4b, are ca. twice as long as the female equivalents, but 3a has ca. 1/4 of the length of female one. A pair of very small setae 2 present. Ventral setae are (Fig. 2) quite similar in arangement to female ones.

The leg-chaetotaxy of the female may be described by numbering setae on each segmt. from dorsal to ventral side, (Fig. 7, Table 3). Coxal setae absent in legs I to IV. Trochanters have three setae in each of legs I－IV, but one of them is a whip-like, long seta in legs II to IV.

The femurs have five setae, of which two are very long, in leg II, and have four setae in legs I, and three in leg III and IV; F3, 4 and 5 are broad at base. The genu has seven setae in II, six in III and five in IV, of which G5 is long, and G3 and G4 are base-broadened. Tibiae II, III and IV each have six setae, the long base-broadened setae being Ti3 and Ti4, and Ti5 longest. Tarsus II with seven setae, the Ta6 being rod-like. Tarsi III and IV with six setae, of which Ta5 is rod-like in male only. Segmt. III of leg I with 22 setae seems to correspond with combined genu, tibia and tarsus in other legs. The male segmt.

Table 3 Comparison of the leg-chaetotaxy formulae between each stages.

segments \ legs		Female (Male)				2nd nymph				1st nymph				2nd larva			1st larva		
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	I	II	III
coxa		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
trochanter	1	(3)	sn	sn	sn	(0)	sn	sn	—	(0)	sn	sn	—	(0)	—	—	(0)	—	—
	2		sn	sn	sn		—	—	—		—	—	—		—	—		—	—
	3		n	L	L		—	—	—		—	—	—		—	—		—	—
femur	1	(4)	sn	sn	sn	(4)	—	—	—	(4)	—	—	—	(4)	—	—	(4)	—	—
	2		L	—	—		sn	sn	—		sn	—	—		—	—		—	—
	3		nb	—	—		—	—	—		—	—	—		—	—		—	—
	4		L	nb	nb		eL	—	—		eL	—	—		eL	—		en	—
	5		L	nb	nb		—	—	—		—	—	—		—	—		—	—
genu	1	(22)	sn	sn	sn	(6)	—	—	—	(6)	—	—	—	(6)	—	—	(6)	—	—
	2		sn	sn	sn		—	—	—		—	—	—		—	—		—	—
	3		nb	—	—		—	—	—		—	—	—		—	—		—	—
	4		nb	nb	nb		n	n	—		n	sn	—		—	—		—	—
	5		L	nb	nb		—	—	—		—	—	—		—	—		—	—
	6		L	L	L		—	—	—		—	—	—		—	—		—	—
	7		sn	sn	—		—	—	—		—	—	—		—	—		—	—
tibia	1		sn	sn	sn		sn	—	—		sn	—	—		sn	—		sn	—
	2		n	n	n		n	s	—		sn	sn	—		sn	sn		sn	sn
	3		nb	nb	nb		—	—	—		—	—	—		—	—		—	—
	4		L	L	nb		nb	nb	—		sn	sn	—		sn	sn		sn	sn
	5		L	L	L		en	en	m		en	en	—		esn	esn		esn	esn
	6		n	n	n		—	—	—		—	—	—		—	—		—	—
tarsus	1		L(LR)	L	L		eL	eL	sn		eL	eL	—		eL	eL		eL	eL
	2		esn	esn	esn		esn	es	—		esn	esn	—		esn	esn		esn	esn
	3		sn	sn	sn		sn	sn	—		sn	sn	—		sn	sn		sn	sn
	4		esn	esn	esn		esn	esn	m		esn	esn	—		esn	esn		esn	esn
	5		esn	esn(nR)	L		esn	esn	—		esn	—	—		esn	—		esn	—
	6		nR	en	en		nR	en	—		en	en	—		nR	esn		nR	esn
	7		sn	—	—		en	—	—		esn	—	—		esn	—		esn	—
claw		0	2	1	1	0	1	1	1	0	1	1	—	0	1	1	0	1	1
total number of setae		29	28	24	23	10	15	12	3	10	15	10	—	10	12	8	10	12	8

m : micro setae, sn : short nude setae $\leqq 8\mu$, sb : short base broaded s., n : nude s. 8.1—30.0μ, nb : base broaded s. 8.1—30.0μ, L : long s. 30.1$\mu\leqq$, R : rods., e : tip expanded s..

III of leg I has three minute, peculiar-shaped setae which are tip-expanded, pyramidal, or clawlike and arise commonly from the inner lateral portion, while the female has only common nude setae. Most leg-setae arise on ventral surface. The leg-chaetotaxy in both sexes seems altogether similar to each other but disimilar in several respects ; Ta1 of leg II and Ta5 of leg III have rod-like setae in male, but the equivalents in female have long whip-like setae. Ta2, Ta4, Ta5, and Ta6 of legs II to III are tip-expanded setae.

Nymph : Its two stages are well different from the adult in dorsal body setae which have leaf-like, oneside-expanded form. The chaetotaxy is modified in that all setae are transferred toward hinder half of body. They are of more complex structure than those in the other stages. 8a and 8c absent. The ventral side has four pairs of setae (v2, v3, v5, v6) but v6 absent in 1st nymph. Leg-chaetotaxy is distinct from that in the adult in fewer seta on trochanter, femur and genu each. It is characteristic of all nymphal and larval

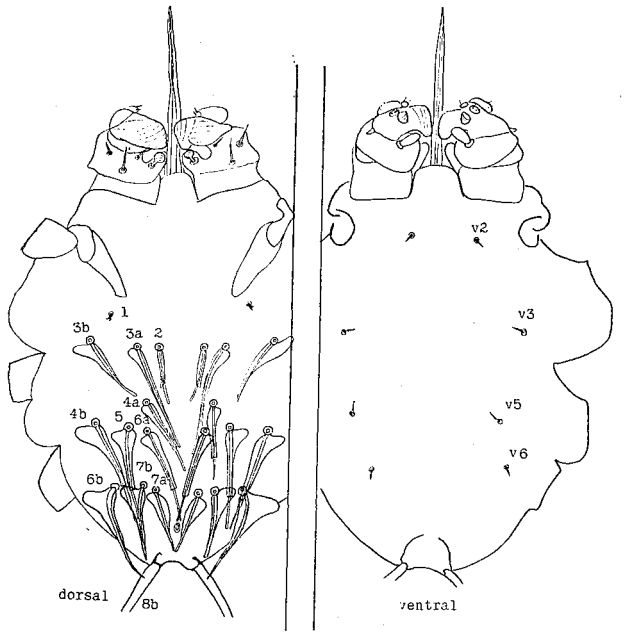


Fig. 3 *R. ensifera*, 2nd nymph, dorsal and ventral views.

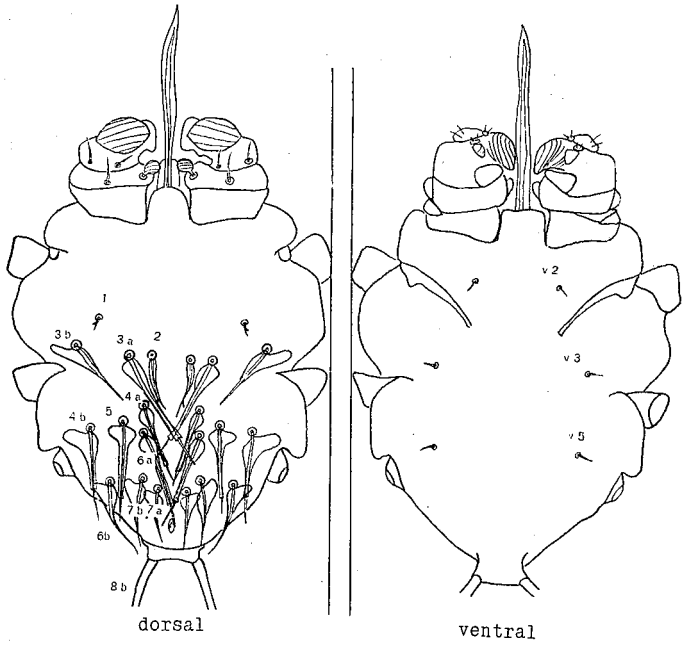


Fig. 4 R. *ensifera*, 1st nymph, dorsal and ventral views.

stages that the inside of segmt. II of leg I has two small fist-like, deformed setae, one in ventral and another in dorsal side.

Larva: This is divided into two distinct stages by general form of setae which are bilaterally leaf-like at base, instead of onesided form in those of nymph, in 2nd larva, while triangle-expanded setae are on posterior portion in 1st, but 6b of 2nd larva 3a of 1st one are exceptional. Body chaetotaxy is alike to that of nymph but 7b absent in 1st larva. The 1st larva is much smaller than any other stages. Ventral setae consist of only one pair (v2) in 1st larva and of three pairs (v2, v3, v5) in 2nd. Leg-chaetotaxy (Fig. 7, Table 3); no setae in coxa and trochanter, four setae in femur of leg I, and one in F4 of leg IV. Genu absent in larva. Tibia and Tarsus similar to those of nymph in chaetotaxy. Among the leg setae in nymph and larva, F4, Ta1, Ta 2, Ta4, Ta5, Ta6, Ta7 and Ti5 are modified into oar-like shape.

Egg: The eggs are attached singly to the base on rather large hair by the help of glutinous secrete that encircles the hair and envelops the egg base. The egg is quite similar in form to, but much smaller than, that of lice as shown in Fig. 6.

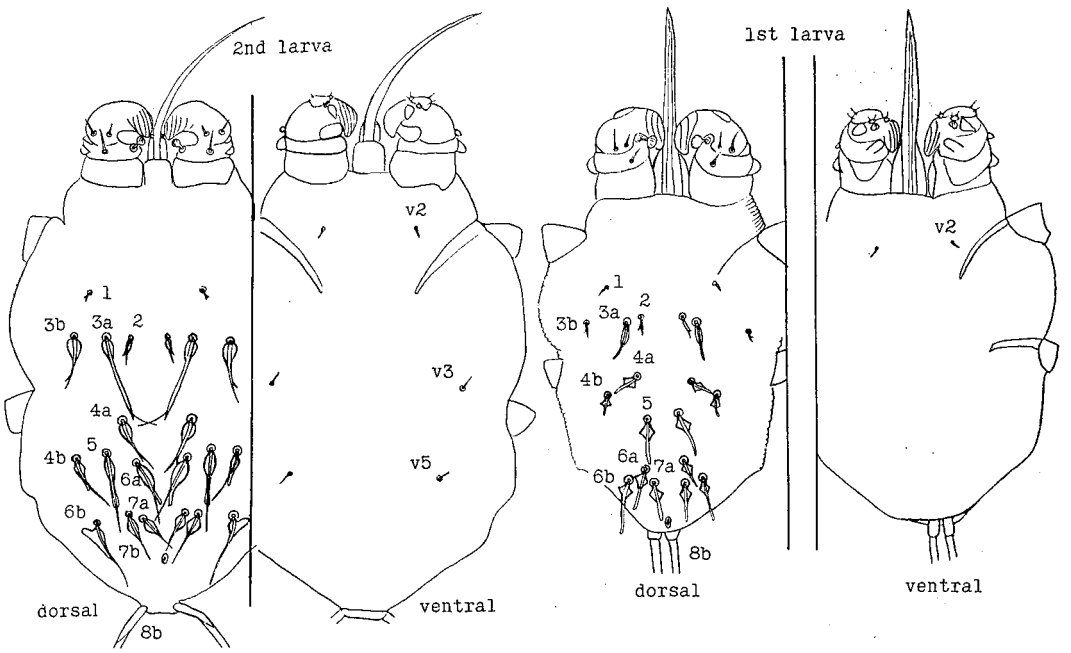


Fig. 5 *R. ensifera*, 2nd and 1st larva, dorsal and ventral views.

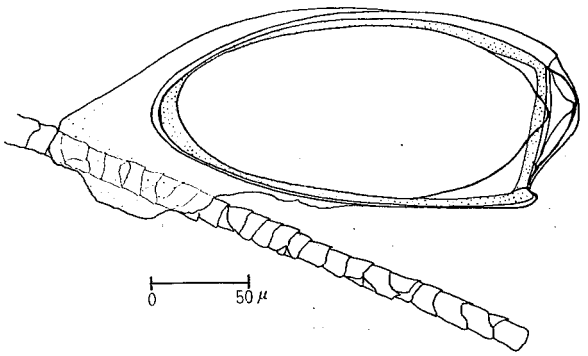


Fig. 6 *R. ensifera*, egg.

Discussion

This mite can be identified as *R. ensifera* by the structure of dorsal spines similar to that and the occurence of a paired claw on leg II. Nymph of *M. davisi* which RADFORD described as a new species from Norway rats, has the same body-chaetotaxy as that of *ensifera*, but the former has a pair of claws, whereas the latter has one claw in Tarsus II and III each at least.

Principal characters differentiating this mite from allied species are as follows ; it looks quite similar to *R. affinis* except the dorsal side having three pairs of leaf-like setae, but its nymph and larva are decidedly distinct from those of *affinis* in body-chaetotaxy as well as in qualities of setae. Some morphological and ecological features, above noted, will be

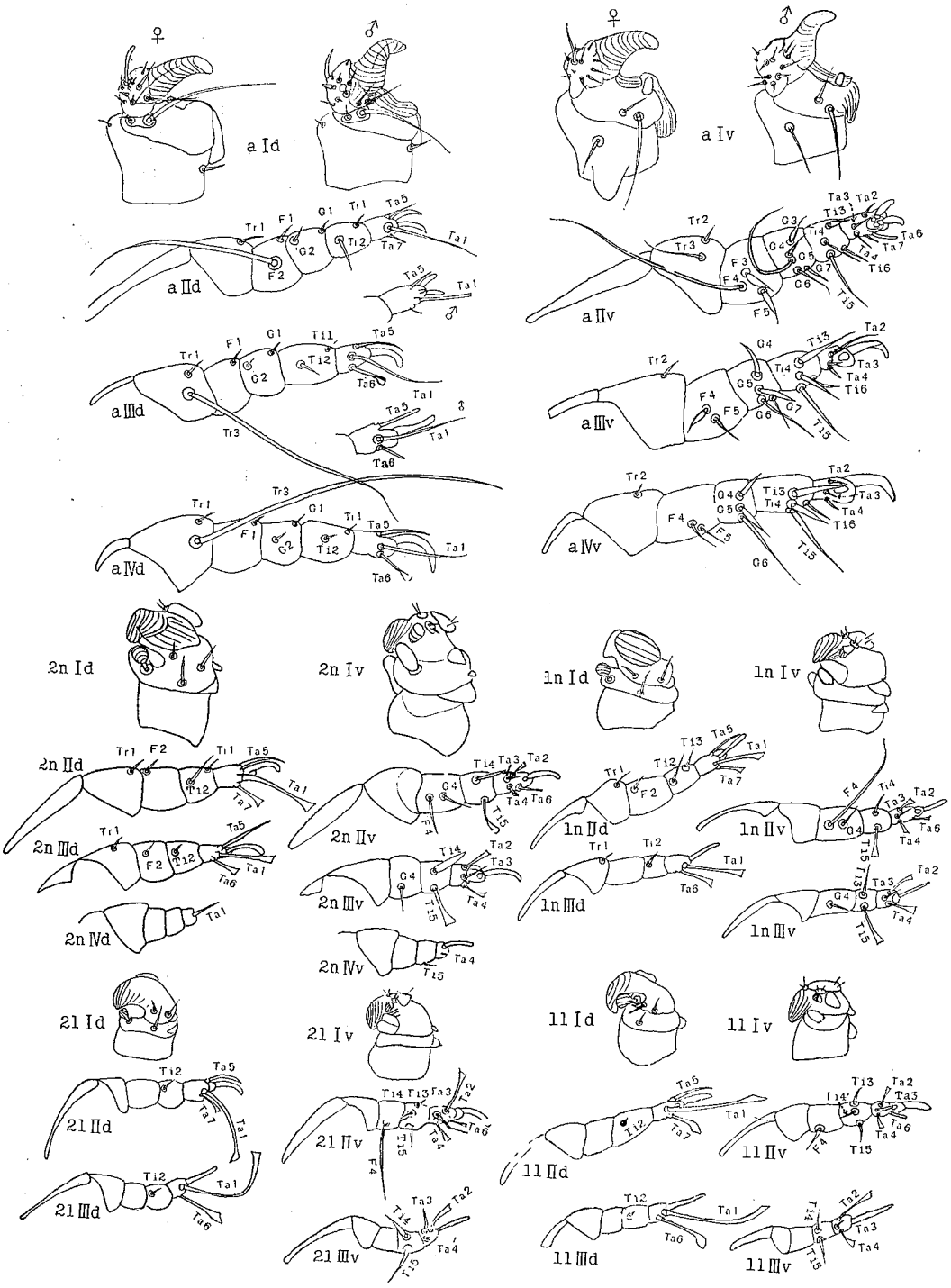


Fig. 7 Leg-chaetotaxy of *R. ensifera*, in all stages.

a : adult, 2n : 2nd nymph, 1n : 1st nymph, 2l : 2nd larva, 1l : 1st larva, d : dorsal halb, v : ventral halb, Tr : trochanter, F : femur, G : genu, Ti : tibia, Ta : tarsus, I : 1st leg, II : 2nd leg, III : 3rd leg, IV : 4th leg.

essentially in common with the parasitic mites on laboratory animals ; this species may represent a parasitic sarcoptid which breeds on body surface through life span, although some remains unsolved about its blood-sucking habit. However, the blood sucked by *M. musuculi* has been confirmed by the positive reaction of blood within mite body, so far as our materials are concerned. A trend of host selection has been recognized by the fact that both mice and rats were infested with two mites, *M. musculi* and *R. affinis*, while the rats were hosts of *R. ensifera* only. The increase of infestation by this mite as the day of rearing wild rats goes on offers an important problem about the method of management for rearing and breeding laboratory animals. In regard to the characters, here considered, my figures are well agreeable with POPPE's rather than RADFORD's.

Summary

Mite specimens, identified as *Radfordia ensifera* (POPPE, 1896), were recovered from albino and Norway rats in Tokyo and Kochi of Japan. By using the ample sample, a morphological study on taxonomic characters was mainly made with special reference to body- and leg-chaetotaxy through all stages, the male, the female, the two nymphal and the two larval, in comparison with allied species. Ecological observation of the mite shows that in general it occurs most abundantly in winter and on the head of hosts.

References

(1) BAKER, E. W. et al. 1956 A manual of parasitic mites, New York. (2) EWING, H. E. 1938 Proc. Ent. Soc. Wash., 40 : 180–197. (3) GRANT, C. D. 1942 Microent., 7 : 64–76. (4) JAMESON, E. W. 1955 Jour. Parsitol., 41 : 407–416. (5) MATUZAKI, S. 1961 Jap. J. Sanit. Zool., 12 : 1–24. (6) POPPE, S. A. 1896 Zool. Anz., 19 : 337–349. (7) PRATT, H. D. & et al. 1947–'49 Atlas of rat ectoparasites, I–III, U. S. Publ. Health. Serv., Atlanta. (8) RADFORD, C. D. 1934 North Western Nat., 9 : 356–364. (9) …… 1938 Parasitol. 30 : 427–440. (10) …… 1949 Bulletin de Muséum, 2e, 21 : 692–697. (11) …… 1950 Bulletin du Muséum, 2e, 22 : 360–363. (12) …… 1954 Ann. Mus. Congo. Tervueren, in-4, Zool., 1 : 238–248. (13) SASA, M. 1958 Jap. J. Exp. Med., 28 : 11–34. (14) WOMERSLEY, H. 1941 Rec. South Australia Mus., 7 : 51–64.

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